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RCA SCIENTIFIC INSTRUMENTS NEWS

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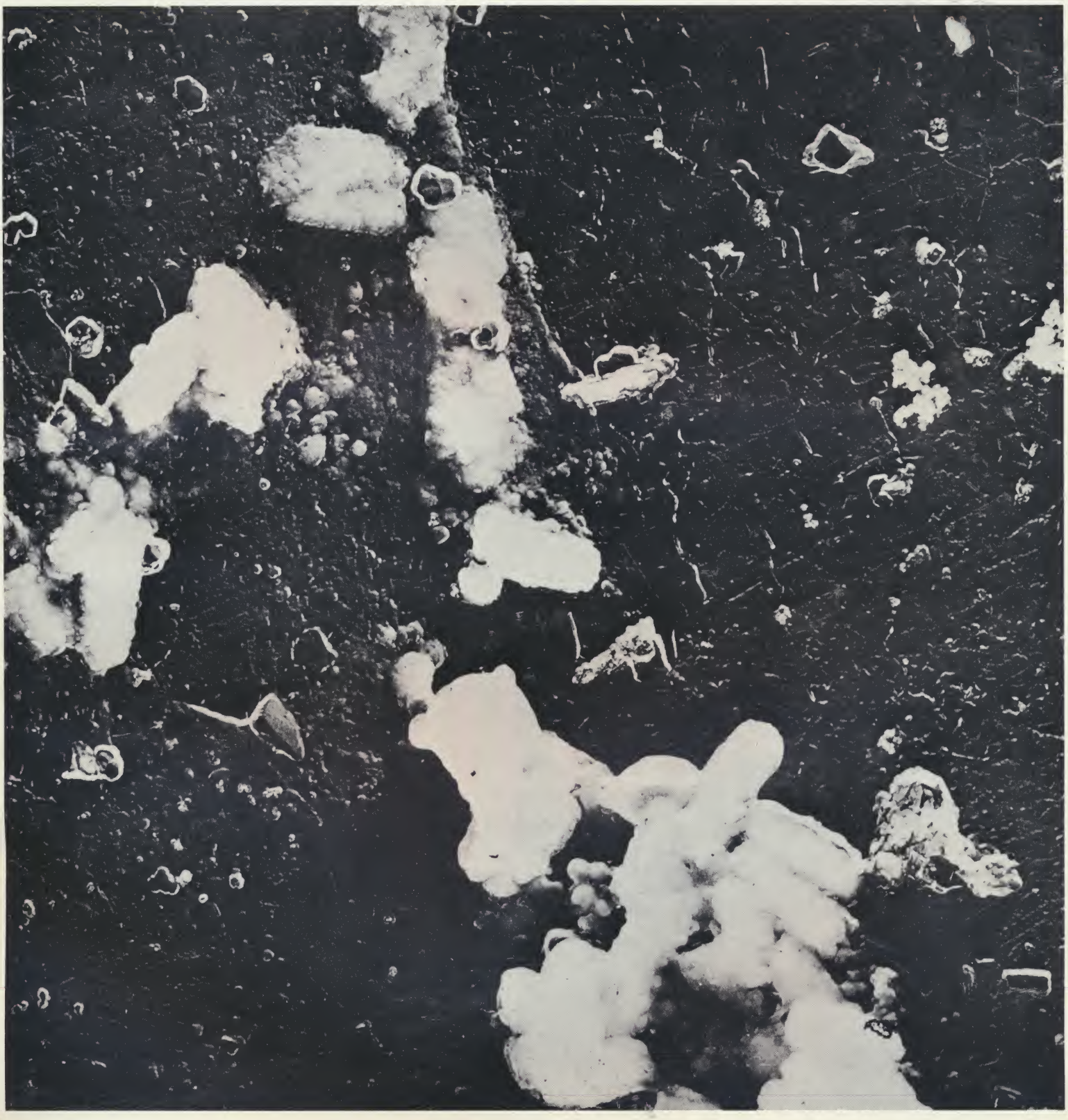
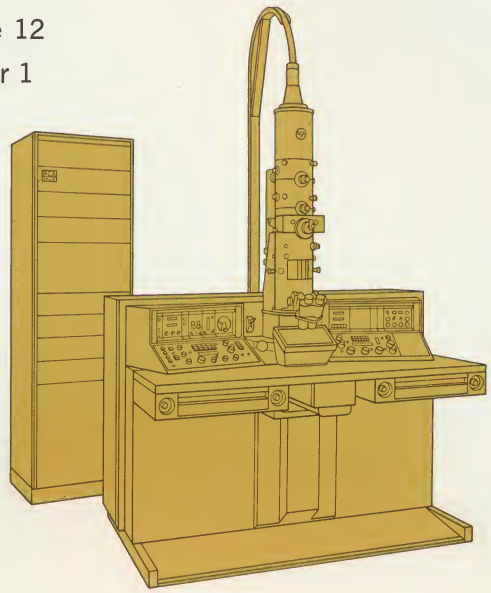


SCIENTIFIC INSTRUMENTS NEWS

Volume 12
Number 1



Scientific Instruments Marketing and Engineering
Building 15-7, Camden, New Jersey, U.S.A. 08102

Scientific Instruments News is published quarterly by the Radio Corporation of America, Broadcast and Communications Products Division, Scientific Instruments Department. This department is concerned with the design, manufacture and marketing of RCA Electron Microscopes, microscope accessories and associated products.

This publication is distributed to those engaged in the development and applications of electron microscopy—to provide a medium by which RCA-equipped microscopists may discuss their professional work.

The purposes of the publication are to disseminate technical information of professional value to the scientific community, by reporting on important developments in electron microscopy, revealing results of research by microscopists, and by describing various new products RCA offers.

Articles Solicited — Microscopists are invited to submit abstracts or manuscripts of articles suitable for publication. These should be original manuscripts, neither copyrighted nor pending publication elsewhere.

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News Briefs

ADDITIONAL PERSONNEL AND ENLARGED FACILITIES FOR RCA SCIENTIFIC INSTRUMENTS

N. Vander Dussen

As part of a new program to expand service to the scientists of the nation and the world, Mr. Neil Vander Dussen — manager of RCA Scientific Instruments — announced an organizational realignment and the acquisition of new facilities. These moves make possible the production of new and improved scientific instruments.

"The challenge to today's scientific community is greater than ever" said Mr. Vander Dussen, "as the frontiers of knowledge roll back and increased demands are made of research and development efforts. To assist in these efforts, we are adding new people to our staff and enlarging the engineering, production and training programs. The result is sure to be more and better tools for scientific investigation.

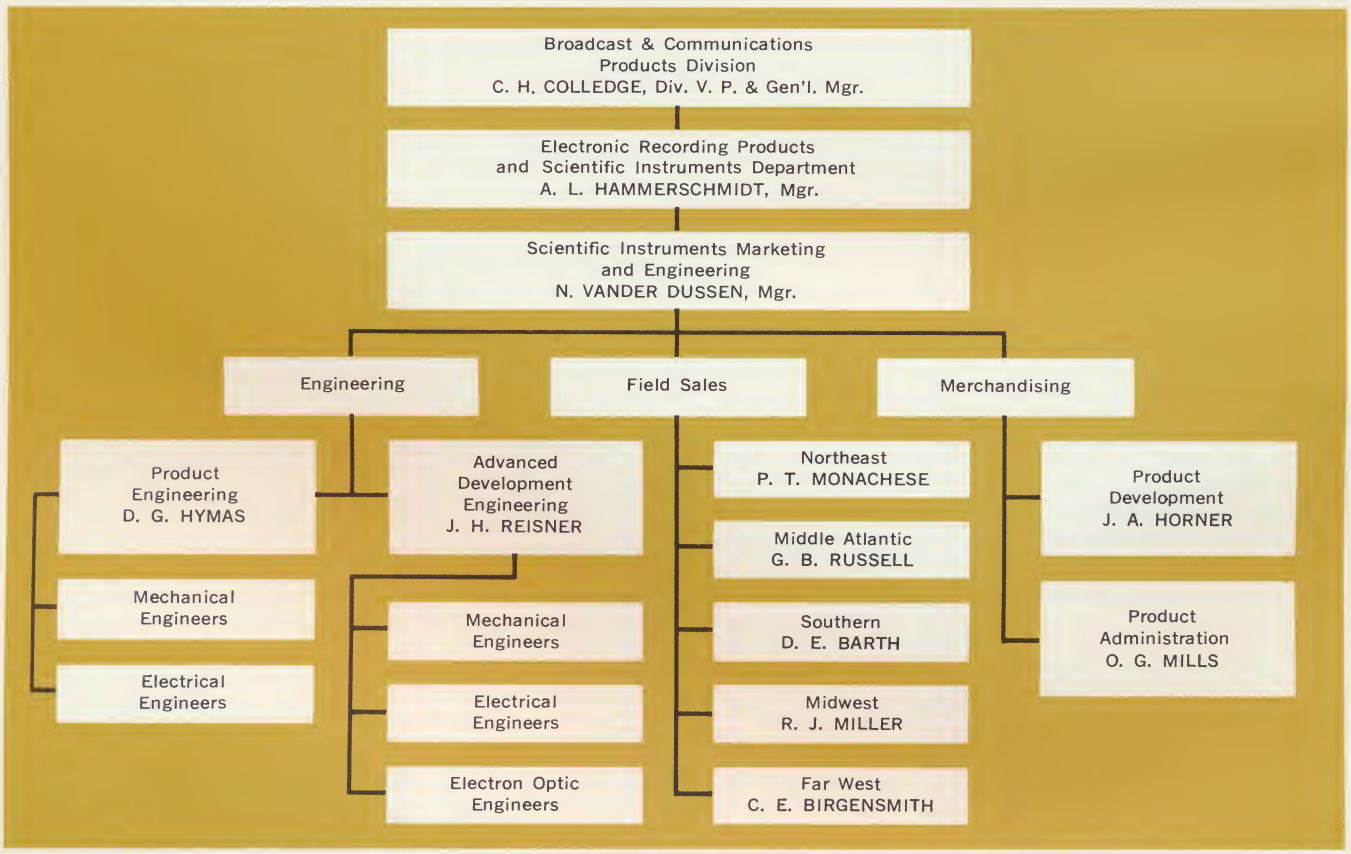
The new organization combines engineering, merchandising and sales functions in one department within the Broadcast and Communications Products Division of the Corporation. B&CP Division is the industrial electronic products arm of RCA (as opposed to military, home-entertainment, data-processing and other product lines).

In his new capacity, Mr. Vander Dussen is responsible for the engineering, merchandising and sales functions of the scientific instruments product line. His engineering organization includes Dr. John H. Reisner as head of Advanced Development Engineering and Mr. Don G. Hymas who oversees the activities of Product Engineering. So that these two groups have the creative "elbow room" they need, their lab facilities have been enlarged appreciably.

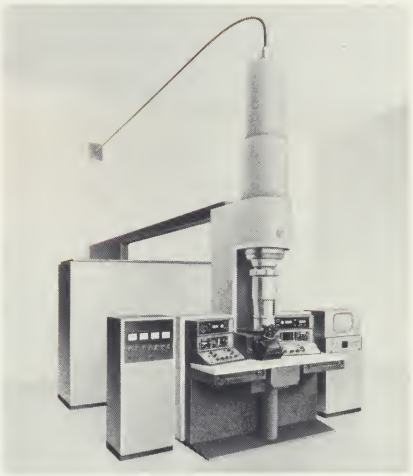
The details of Scientific Instruments Merchandising are divided into two responsibilities: Product Development through Jack A. Horner and Product Administration by "Bud" Mills.

Five field representatives, Don E. Barth, Charles E. Birgensmith, Peter T. Monachese, Raymond J. Miller and George B. Russell (see rear cover) manage the several sales territories under the guidance of Mr. Vander Dussen.

This new organization is staffed and equipped to extend RCA's service to the scientific community with qualitative and quantitative instruments that combine usefulness, reliability, and long life with reasonable cost.



FIRST RCA 500-KV EM TO GO TO UNIVERSITY OF VIRGINIA



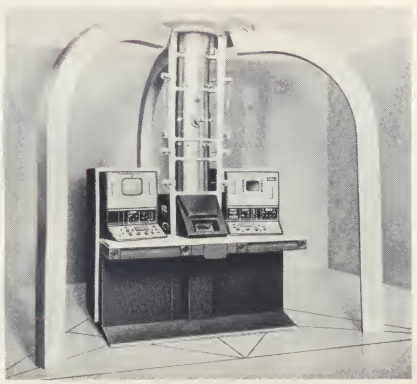
The University of Virginia has placed an order on RCA to build the first American-made 500-kilovolt electron microscope.

To cost $300,000, the new instrument is to be installed in the University's Department of Material Sciences, headed by Dr. Heinz G. F. Wilsdorf.

Dr. Wilsdorf said that the 500-kV instrument's increased penetrating power will allow the use of thicker metallurgical and biological specimens that a conventional 100-kV instrument can handle. The greater specimen thickness should provide scientists with additional ultrastructure information that could lead to improvements in spacecraft materials or fresh knowledge useful in treating or controlling diseases.

The super instrument is to be equipped with an image intensification system that uses television components. Dr. Wilsdorf said that the image-intensifier permits a low-intensity electron beam in the study of materials which are sensitive to electron bombardment. Low beam intensity delays the alteration that occurs in such materials.

U. S. STEEL ORDERS CUSTOM-BUILT MILLION-VOLT ELECTRON MICROSCOPE COLUMN FROM RCA



RCA is designing, fabricating and testing a million-volt electron-microscope column under contract to the United States Steel Company for installation at USS' Monroeville (Pa.) research facility.

The instrument, 29 feet from top to bottom, is about three stories high. The photograph here shows the column portion of the instrument.

Among the many unique features designed into the instrument is its "hanging" column support. Each of the six lenses of the column (two condensers, one objective and three projectors) is supported on a stainless-steel frame which hangs from a tripod support at ceiling height. This design allows the massive weight to be distributed to the building foundation instead of on the viewing chamber.

So that one person can operate the entire instrument from a single point, the design makes use of remote control and closed-circuit TV.

Scheduled for delivery during Summer, 1967, the instrument is the first million-volt electron microscope built for delivery against a customer order.

UNIVERSITY OF BRUSSELS HOSTS COMBINED MICROSCOPY CONVENTIONS

May 22, 23 and 24 are the dates of the forthcoming combined conventions of two European electron microscopy societies. The two groups are the *Societe Belge de Microscopie Electronique* and the *Societe Francaise de Microscopie Electronique* meet on the campus of the University of Brussels.

The RCA Display at the SBME/SFME commercial exhibition features a fully-equipped EMU-4 Electron Microscope and a TR-5 TV-Tape Recorder.

The electron microscope is arranged so that exhibition visitors may operate the instrument for themselves. The television system is set up to play a pre-recorded tape of various image-intensified microscope images to illustrate the usefulness of TV tape recording in capturing transient microscope phenomena.

Mr. Milo Cermak of RCA's overseas division, RCA International, will be in attendance at the exhibit.

EXTRACTION OF PHASE-CONTRAST INFORMATION FROM TV-DISPLAYED MICROSCOPE IMAGES

Space Probe Data Correlation Techniques May Help to Extract Phase Contrast Information from Electron Microscope Images

JOHN W. COLEMAN
Radio Corporation of America
Scientific Instruments Engineering Dept.

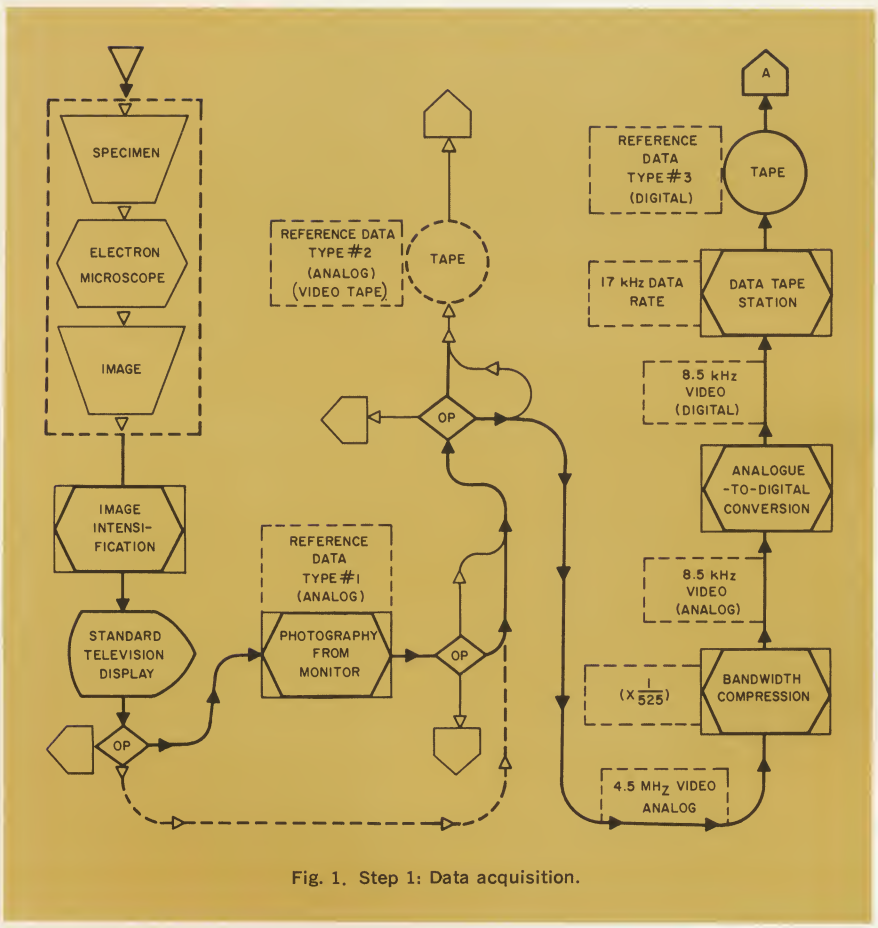


Fig. 1. Step 1: Data acquisition.

Introduction

An important factor determining electron-micrograph resolution is image contrast. This contrast is of two types: *amplitude* and *phase*.

Amplitude contrast depends upon the mass and diffraction characteristics of the specimen. It is the dominant type of contrast in resolved images of objects down to about 8 angstroms in size. To a first approximation, amplitude contrast increases with the amplitude of the scattered electrons which are forced to lie *outside* of the objective lens aperture.

Phase contrast, on the other hand, comes only from the scattered amplitude *inside* the objective aperture i.e., the imaging electrons. Phase contrast presents an important opportunity for resolution at the atomic level although the extent of phase information contribution to image contrast is severely limited by spherical aberration in the objective lens. Spherical aberration, in effect, "scrambles" the phases by an amount which increases numerically as an exponent of the scatter angle. No contrast-enhancing device is capable of overcoming the effect of scrambled phase information due to objective spherical aberration.

This paper discusses the possibility that the "unscrambled" (yet-to-be-scrambled) phase information present in the image of present-day microscopes might be enhanced through the use of techniques borrowed from the world of electronic data processing if the microscope image is made available as a series of data bits plotted against time. Conversion of the image to a television signal accomplishes this but not in a form compatible with data-processing hardware. The discussion that follows suggests a method that might be useful.

Phase Contrast

For a perfect (theoretical) objective lens, the image plane amplitude distribution (the "imaging" integral) is the Fourier transform of the diffracted amplitude distribution at the back focal plane (which in turn is the Fourier transform of the distribution of object inner potential). For real (practical) objective lenses the Fourier transform to the image plane is of low fidelity owing to the lens aberrations (mainly spherical) and the finite size of the aperture because the aperture not only limits the point-to-point distance phase information from the specimen by removing larger spacings from the diffraction pattern at the back focal plane, but also adds its own diffraction pattern. For real lenses, the phase X in the back focal plane is a polynomial[1] including terms which set the phase changes due to (a) diffraction by the object, (b) scrambling effect of spherical aberration, (c) the effect on the electron scattering amplitude for a single atom, and (d) the effect of defocussing the lens by an amount Δf. Only the last effect, that of Δf, is of concern in the possibility of emphasizing phase contrast by data corelation techniques when the image is displayed with television.

Phase Contrast From Defocus and Spherical Aberration Using Present Objectives

The variation in phase contrast with defocus is well known, with almost

zero phase contrast at exact focus. Maximum contrast is obtained upon weakening the objective (Δf positive). Even at maximum however, contrast is in the range of only 5 to 10% with a typical state-of-the-art objective (no phase plate and $C_s = 3$mm). Heidenreich[2] used a computer to plot the amplitude profiles for such a typical lens with defocussing ($0 \leq \Delta f \leq 4$), and his data indicates that a chain of five groups of three gold atoms per group with a spacing of 8 Å between groups might be visible in the image, having a contrast ratio of about 12%. The problem remains how to extract this small amount of recurring contrast information from the total image. Substrate and thermal motion cannot be ignored: the former must not contribute significant inelastic scattering; the latter must be reduced to a minimum with a cold stage. The effect of thermal motion is particularly detrimental to phase contrast.[3]

The Enhancement of Phase Contrast From Defocus in Present-Day Instruments

The main opportunity for resolving single layers of atoms with present-day, typical objective lenses is in the defocus technique (to enhance phase contrast) coupled with cold-stage microscopy (to minimize thermal motion), the use of low-noise specimen substrates (to reduce background), larger objective apertures (to allow the higher spacing frequencies from the back focal plane), low beam intensity (to minimize specimen contamination) and relatively broad beams (but nearly "zero" angular aperture). Some form of image intensification is thus indicated.

The Advantage of a TV Display of the Intensified Image

Space technology has developed techniques for extracting some types of masked information from TV images. The treatment of analog television images by initial analog-to-digital conversion, subsequent treatment of digital point-to-point information, and final digital-to-analog reconversion is developing rapidly into a powerful data-gathering tool. The general process is called *data corelation*. Converted to a TV signal, an electron microscope image becomes, in principle, immediately available for image data manipulation. Thus, a TV displayed microscope image offers the possibility for extracting phase contrast information derivation effectively allowing phase contrast enhancement.

Informational Contents of a Television Signal

The information contained in a (U.S.) standard 525-line, 30 frames/second television signal may be evaluated in the following manner:

Using the sampling theorem, a time signal of which the highest frequency component is f (4.5 MHz in the 525/30 system) may be uniquely represented as $2f$ samples per second. Since the 525/30 television system requires 1/30 second (33.3 ms) to complete one interlaced frame, the samples contained in one frame are:

$$\text{Samples/frame} = \frac{9 \times 10^6 \text{ samples}}{\text{second}} \times 33.3 \times 10^{-3}$$

$$= 3 \times 10^5$$

The quantity 3×10^5 is significant because it describes the number of samplings required to describe the complete frame (or picture) regardless of the rate at which the sampling is accomplished.

Regarding the accuracy of such a sample, Bell Telephone Labs work[4] (to determine the necessary quantizing levels to encode TV signals for pulse-code modulation) has shown that good rendition can be expected with 32 quantizing levels of the analog signal. On this basis, a microscope image might be digitized into at least 3×10^5 samples, each sample encoded into 5 bits allowing for a 32-level quantizing of the analog signal (a 30-tone gray scale).

It is clearly evident that, depending upon the electronic magnification in the microscope prior to the intensifier-television chain, a single digitized sample from *image* space could easily represent a subatomic area in *object* space. There is nothing in principle to prevent "looking into" an atom with digitized television if the primary microscope image allows it, even marginally. The problem thus becomes the treatment of the television image to extract classes and/or sets of masked information from the total information available.

Treatment of the TV Displayed Microscope Image

It is assumed that the microscope image is available from a (U.S.) standard TV system at 525 lines and interlaced frames at 1/30 second intervals (525/30 system) with a 4.5 MHz video bandwidth. Since it was shown above that the image data content for good rendition must be represented by at least 3×10^5 discrete sampling points, the digital data acquisition rate operating directly from the standard TV system would be:

$$\text{Digital Data Rate with 525/30 System} = \frac{3 \times 10^5}{1/30} = 9 \times 10^6 \text{ characters/sec.}$$

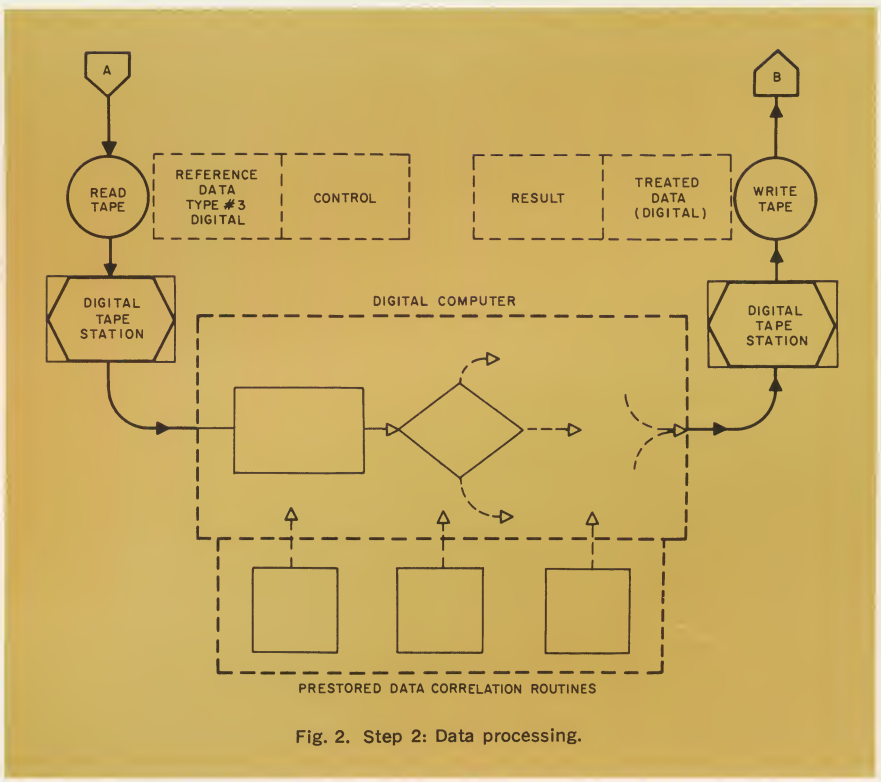


Fig. 2. Step 2: Data processing.

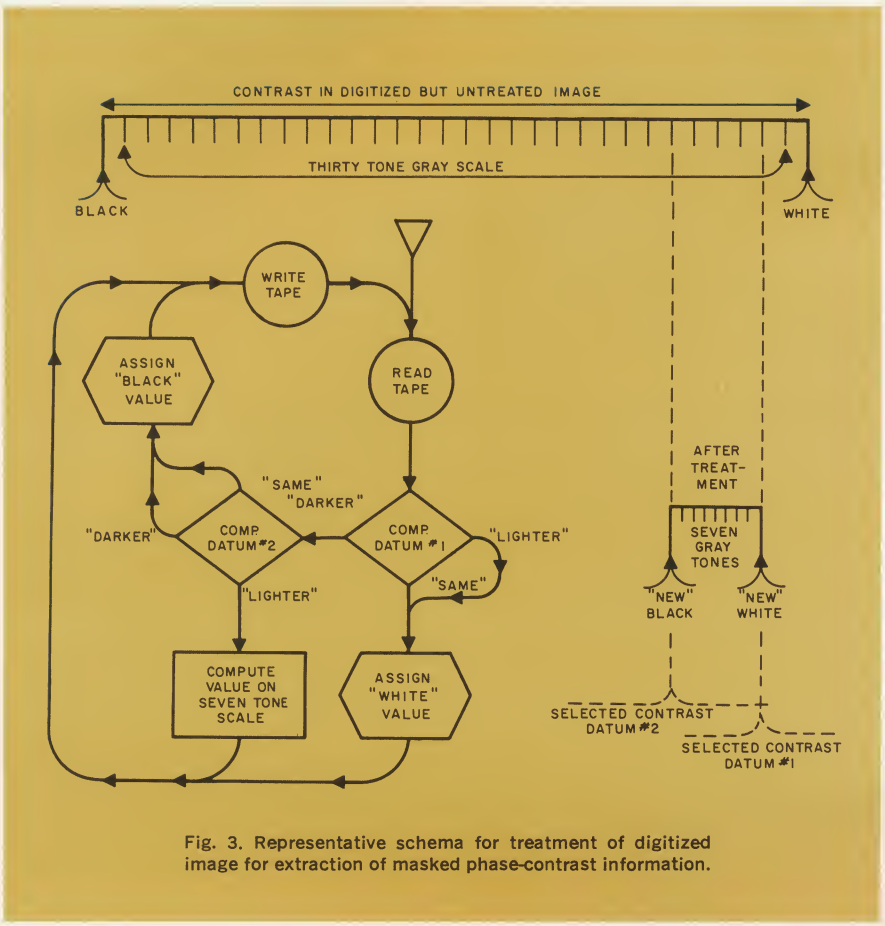


Fig. 3. Representative schema for treatment of digitized image for extraction of masked phase-contrast information.

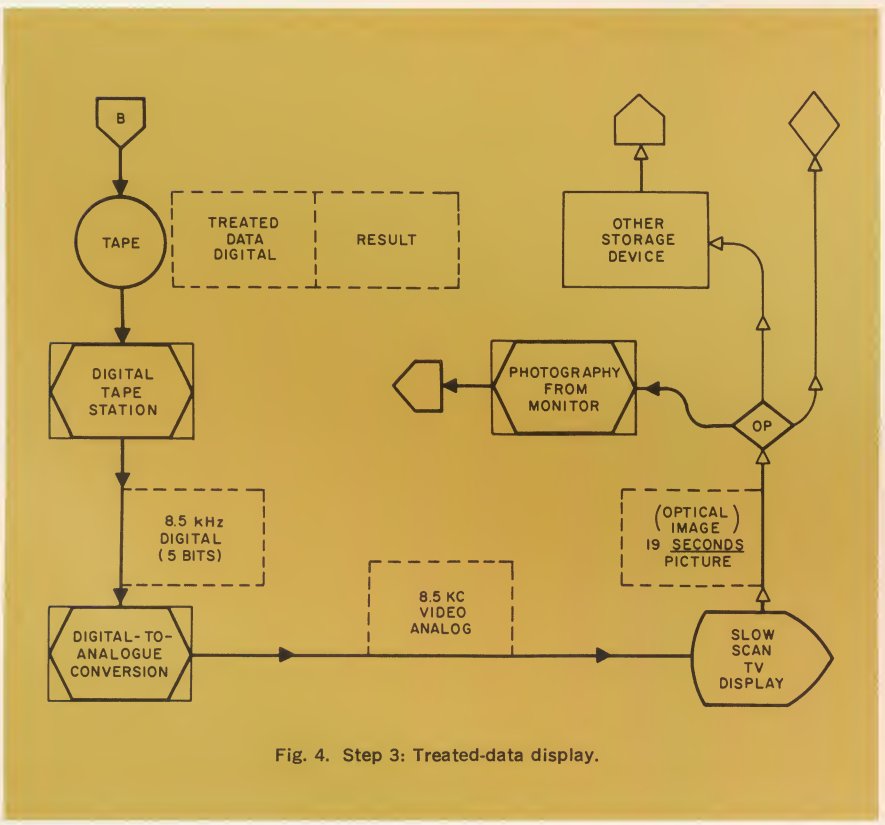


Fig. 4. Step 3: Treated-data display.

This data rate is beyond the "read" capabilities of any currently available sequential data-storage equipment.

Since, however, the data content in the picture is assumed constant and stationary in time, it is possible to reduce the bandwidth of the video signal if the transmission time is extended in such a way that the product of bandwidth and transmission time remains constant in much the same manner playing a phonograph record at half speed halves the bandwidth of the audio but doubles the playing time.

Equipment is presently available commercially which reduces the bandwidth of a 4.5 MHz TV signal to 8.5 KHz, provided the wideband signal is a "still" for the time it takes to generate the reduced-bandwidth signal. This time period is a function of the time in the wideband system multiplied by the bandwidth-reduction ratio:

$$\text{Time for "Compressed" Picture} = 1/30 \times \frac{4500\ \text{KHz}}{8\ \text{KHz}} = \sim 19\ \text{seconds}$$

If the wideband signal is described by 3×10^5 samples, the data-acquisition rate is:

$$\text{Digital-Data Rate, "Compressed" Signal} = \frac{3 \times 10^5}{19} = \sim 16{,}000\ \text{characters/second}$$

This data rate is well within the capabilities of medium-size data-processing equipment. The characters recorded by the digital tape unit for processing in a computer then comprise the output of an analog-to-digital converter which has, as its input the reduced-bandwidth signal (Fig. 1).

Image Treatment for Enhancement of Phase Contrast

If an orderly monolayer of atoms on a non-noisy substrate is assumed along with all conditions fulfilled for high-resolution microscopy, even with the objective lens defocused, probably nothing will be seen with a typical microscope. This is also true in the wideband television display of the image. If the atoms are say, gold, with a few angstroms between centers, there should be phase contrast nevertheless of the order of 6% absolute; this amount, of course, is swamped by the background. If the converted-to-TV image is digitized the question becomes whether treatment of the digitized information can reduce the background and emphasize the phase contrast to the point where a pattern will become apparent in the reconstructed image.

The answer is that this is possible and even probable for gold and heavier atoms. The scheme for image treatment is shown in Fig. 2.

A search by the Aerospace Research Applications Center (Indiana Univ. RSS1932) shows that statistically significant contrast variation of as little as 1.5% can be found and enhanced in "obviously" blank areas of the image.[5]

A representative scheme for such purposes is shown in Fig. 3. Many more-sophisticated and complex schemes may be derived. With such arrangements, the background (coarse information) may be discarded effectively and any phase contrast (fine information) displayed on a new scale of n relative levels representing $X\%$ of total with respect to the background data. Using such techniques therefore, the gold atoms mentioned earlier might emerge as a pattern.

Display of the Treated Image

The schematic of Fig. 4 shows a possible system for the display of the treated image. In principle, a "new" image can be displayed every 19 seconds on the slow-scan video monitor until the desired information is obtained.

Fig. 5 is schematic of the entire microscope-to-monitor system.

Summary

In electron microscopes of current design, the fundamental limitation imposed by objective-lens spherical aberration on phase contrast in the image cannot be overcome by any contrast enhancement scheme or device. The available phase contrast however, might be emphasized (or enhanced) through treatment of the image data in a television-displayed image with techniques evolved for the treatment of TV images received from space probes such as *Ranger, Mariner* and *Surveyor*. With such techniques, it might be possible to extract images of single or clumped atoms in an orderly array in a monolayer.

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2. *loc. cit.*
3. Horstmann, M. and Meyer G., *Phys. Kondens. Materic.* 1, 1963.
4. E. R. Kretzmer, *Statistics of Television Signals,* BSTJ, July 1952.
5. For Example, see *Analog-Digital Conversion of TV Data on Mariner 4,* John Way, Sr. (Calif. Inst. of Tech. J. P. L. Space/Aeronautics, Vol. 44, Aug. '65).

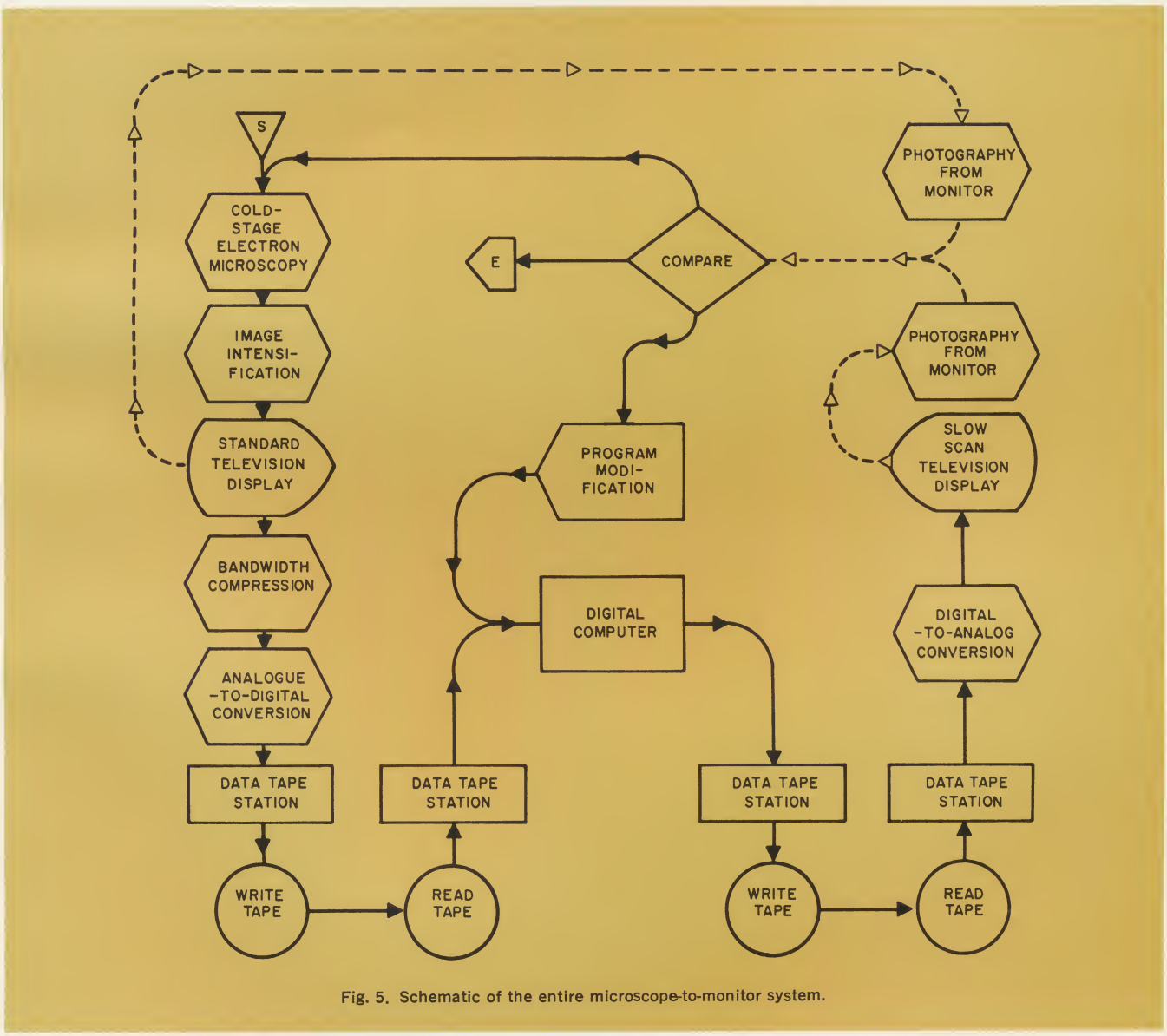


Fig. 5. Schematic of the entire microscope-to-monitor system.

HOLOGRAPHY: RECORDING LIGHT IN THREE DIMENSIONS

A New Use of the Laser Enables Scientists to Photograph a Scene in All Its Colors and Dimensions

BRUCE SHORE
RCA Laboratories, Princeton, N. J.

Editor's Note: This article originally was written for and appeared in ELECTRONIC AGE, a corporate publication of RCA. Because the material contained in it might be of interest to our readers, we reprint it here in its entirety.

In a feat of cryptography as stunning in its way as the breaking of the Japanese diplomatic code on the eve of World War II, scientists have succeeded in cracking the phase "code" of light. Using the laser as an electromagnetic Rosetta stone, they have developed a new kind of photography that makes it possible to record an object or scene in all its colors and in all three dimensions. Not only that, but the resulting image, when viewed from various angles, undergoes all the optical variations associated with a scene as viewed through a window.

For instance, the background blurs when the eye is focused on the foreground and vice versa; objects behind structures in the foreground pop into sight when the angle of view is changed; the entire scene continues to be visible even when part or most of it is covered, just as it does in a window when the shade is pulled halfway down.

List of Possible Applications Staggering

Dubbed *holography*, from the Greek meaning "to record everything," this new technology has already led the nation's major research laboratories to assemble small bands of mathematicians, physicists, and specialists in optics to conduct spoiling raids across its frontiers in search of new understanding and new applications of light.

From these forays eventually may come three-dimensional color movies and, possibly, TV, neither of which will require special glasses to be viewed; three-dimensional photographs and paintings that occupy no more space than the two-dimensional versions we now hang; computer memories that store information in the form of light patterns registered not only on the surfaces of certain materials but in their bulk as well; devices that can store ultrasonic sound patterns in such a way that they can be read out with light after they have been used "to photograph" the interior organs of the body; other devices that can record X-rays and be read out with visible light in a magnification process which may make it possible to see atomic structure in three dimensions for the first time; new optical instruments for measuring air pollution in volume, for performing remarkably accurate analyses of objects under stress, and for doing contour mapping. The list of possible applications of holography grows longer and more fantastic every day.

Lensless Photography

The product of holography—called a *hologram*—is usually a large glass slide that is either completely transparent or slightly hazy. If hazy, further investigation under a high-powered microscope reveals that one side of the halogram has a peculiar graininess consisting of dark and light ripples scattered through it in ostensibly random fashion.

These curious patterns are actually frozen into a photographic emulsion that has been exposed directly to an object illuminated by a laser without the intervention of a lens. Since even the eye sees nothing but a blur without its natural lens, it is not surprising that the emulsion contains no recognizable image. What it does contain is a record in the form of microscopic particles of precipitated silver (produced via the same chemistry used to make conventional negatives) of where the varying intensities of light reflected from the object fell on it.

Principles Involved

Holography depends upon the phenomenon known as optical interference, which was first explained in 1801 by the British physicist Thomas Young. Optical interference is the cause, for example, of the rich color patterns frequently seen on oil slicks and soap bubbles.

At the root of the phenomenon is

Fig. 1. A reflection hologram is read by a blue laser beam. The real and reverse images of a film slide are shown at either side of the beam.

Fig. 2. A red laser is used here to project real images of a Schubert figurine and a music sheet.

Fig. 3. An RCA Laboratories researcher adjusts one of the laser lenses to focus a hologram.

the fact that light passes through space as a series of electromagnetic waves. Normal light comprises waves of many different frequencies and phases—like waves on the surface of water in a changing wind—and they tend to interfere with one another in random and uncontrolled fashion.

The light of a laser beam, however, is made up of waves of one frequency that are synchronized so that they move in uniform phase. This characteristic gives laser light a precision and coherence that is absent from ordinary light, and it makes possible a control over optical interference that is the basis of holography.

In holography, the laser beam is split in two. One beam is directed at the object to be holographed, while the second, or reference beam, is sent directly to the photographic plate. The first beam, reflected from the object toward the plate, undergoes changes in phase and intensity that do not affect the reference beam on its direct path.

When the two beams meet again in the photographic emulsion, they interfere in such a way as to record not only the average intensity of the light reflected from the object, but also the direction of each wave in the light as revealed by the pattern of interference. The result is a hologram, a three-dimensional image registered in the emulsion in the form of changes in the spacing and density of the silver particles.

Viewed with Coherent Light

When the stored image is exposed again to the coherent light of a laser beam of the same frequency, the effect for the viewer is a reconstruction of the original object, apparently floating in space some distance behind the photographic plate and possessing all of its original dimensions.

Though holograms of complete images are new, holograms of single points of light go back to 1818 when the great French physicist Augustin Fresnel demonstrated what has since come to be known as the *Fresnel zone plate*. This is a glass plate on which narrowly spaced concentric circles have been scribed in accord with a highly precise formula. As a result, when an ordinary light beam of a single color passes through it, the beam undergoes interference so that a point of light can be seen to hover behind it in space if an observer looks through it toward the light beam. Thus, a modern hologram is really many Fresnel zone plates superimposed so that each produces its own point of light at its own unique focus, and all add together to form an image.

First Demonstrated in 1891

Even the idea of producing images—and vivid colors—by using the phenomenon of light interference is not new. It was first conceived by William Zenker, of Berlin, in 1868, and first demonstrated by the French photographer Gabriel Lippmann in 1891. What Lippmann did was to use a thin, transparent emulsion on a glass slide backed by a shiny surface of mercury. When the light waves from an object to be photographed penetrated the emulsion and were reflected back by the mercury, they met and interfered with others just entering the emulsion. (This is exactly how an oil slick on water produces the interference colors we associate with it.) The result was a series of interference patterns trapped in the emulsion. These could be made to reproduce full, two dimensional color images by the simple expedient of shining a strong white light on them at the proper angle. In fact, Lippmann photographs were the first true color photographs ever made from life.

High-Contrast Microscopy

Once again, in 1934, the principle of light interference set the world abuzz with the development of the phase contrast microscope by Frits Zernike in Holland. For years, the study of biological specimens—human tissues, microbes, and other organic material—had been impeded by the fact that they were almost completely transparent to the eye of the microscope. Zernike found, however, that if the light being used were split so that a portion went through the specimen and another portion went through a transparent piece of mica, the two got out of phase and interfered when they were brought back together. The result was a high-contrast microscope for use in biological research for the first time. In 1953, Zernike won the Nobel Prize for this work.

Fig. 4. An illustration of the three-dimensional capabilities of a hologram. As it appears, we see a man grasping a 3-D model of a crystal lattice on the far side of a small window. In reality, the window is a transmission hologram and the lattice model, a three-dimensional holographic image. The man's hand is the real thing.

Fig. 5. An optical-bench setup for producing holographic images. The argon laser enters at upper left and is split by a half-silvered mirror at upper right. The two beams then follow separate paths—the left one to the object to be holographed (a film slide, in this case) and the other, the reference beam—to a point where the beams converge and the hologram is formed on a photo plate at lower left.

Electron Interference Patterns

The next major development in the use of interference phenomena was Dennis Gabor's concept of three-dimensional, holographic imaging propounded while he was working at the Imperial College of Science and Technology in London in 1947. He hoped to use the wave nature of electrons to create electron interference patterns from which he could reconstruct magnified images by optical rather than electronic means. Unfortunately, he could not get the necessary coherence in the electron beam.

1960 and the Laser

There things remained until 1960 and the development of the first laser, a pulsed device made of a ruby crystal impregnated with chromium atoms. This was complemented later by the gas laser—a tube-shaped device that emits coherent light continuously.

Seizing on this development and improving on the concepts of Gabor by introducing the idea of a reference beam to create interference, Emmett Leith and Juris Upatnicks, working with a gas laser at the University of Michigan in 1962, produced the first hologram to give three-dimensional images. The scientific world has not been quite the same since.

Holography at RCA Laboratories

Today, four years later, there is scarcely an electronics research laboratory not investigating the subject. At RCA Laboratories in Princeton, N. J., for example, scientists such as Drs. David Greenaway, Hendrik J. Gerritsen, and Edward G. Ramberg are exploring the feasibility of hologram computer memories that store information in three dimensions, hologram movies, and holograms whose images could be magnified in all three dimensions at the same time to father a whole new type of optical microscopy.

At the moment, however, the major aim of these scientists is to gain new and fundamental insight into the phenomenon of holography itself. In that connection, they have produced several novel forms of holograms: phase holograms that record their three-dimensional information on a mirror surface that is read by reflection, holograms whose images are read out in only two dimensions—like conventional photographs—but with the difference that such "snapshots" are only one-twenty-fifth of an inch on a side, and holograms that store not one but many images. Soon they plan to produce an improved "white-light" hologram—one made in laser light but one that can be read in ordinary daylight . . . a kind of Lippmann photograph in three dimensions.

The ability of holograms to produce standard photographs rests on the fact that they can be made to reconstruct two types of three-dimensional images; one, the so-called *virtual image,* appears only when you look through the hologram in the general direction of the read-out laser beam; the other, called the *real image,* is seen on the other side of the hologram and may be recorded in two dimensions by the simple expedient of inserting a screen or photographic plate in the path of the light.

The ability to produce color holograms in three dimensions visible in ordinary light depends on a surprising technique that employs the thickness of the hologram emulsion itself. Different-colored lasers—red, blue, and green—all illuminate the object to be holographed at the same time. The reference beam of each, instead of hitting the front side where the reflected beam is received, is directed to the back of the hologram. As a consequence, the interference patterns created by each are much finer and lie much closer together. If white light is now shone through the back surface of such a hologram, a full-color reconstruction of the virtual image results. This happens because the hologram acts as a color filter—it allows through only those frequencies composing the white light that are close to the ones used to record the image in the first place. So far, such holograms have shown certain drawbacks, however; they are dim and their colors are usually distorted.

With the invention of standard contrast photography by Louis Daguerre in 1839, man found a way to record, chemically, two-thirds of the graphic information encoded in light reflected from an object. Now, with the invention of holography, he has found a way to record the other third. In the process, his ability to investigate and portray the world around him was acquired—both literally and figuratively—a new dimension.

LENOX HILL HOSPITAL USING IMAGE INTENSIFIER IN CANCER RESEARCH

New York City's Lenox Hill Hospital has begun to use an EMTV-1 image intensifier system with their electron microscope in medical research.

Installed in the hospital's Department of Pathology, the system extends the usefulness of an EMU-3H microscope by making visible images that heretofore were too dim to be seen. In addition, the image intensifier boosts the microscope's magnification potential ten-fold to approximately 2,000,000 times.

Gifts of the Kalvin Family

In addition to the microscope and the image intensifier, the system includes a television tape recorder. The intensifier and the recorder are the gifts of Nathan Kalvin, Joseph Kalvin and Mrs. Minnie Kalvin Zeve in memory of their sister, Nettie Kalvin. The room housing the system is designated the Nettie Kalvin Memorial Laboratory.

Dr. Stanley R. Opler, the hospital's Director of Pathology, said that the new image-intensifier system will serve several ends as an aid in training student pathologists; screening biological specimens for viral particles; the investigation of viral particles in leukemia (under a grant from the National Cancer Institute) and for future use in investigations of other cancer forms.

Optical/Electrical System

The image-intensifier device consists of two major assemblies: an optical system which fits inside the instrument console as shown in Fig. 2 and a caster-mounted cabinet that contains various electronic circuitry, an oscilloscope waveform monitor (which serves as an image densitometer) and a swivel-mounted picture monitor. This cabinet is shown in Fig. 3.

Referring to the block diagram of the system in Fig. 4, the optical position of the system is represented by items 1 through 8; all other parts of the system (except for the optional tape recorder) are within the wheeled cabinet (Fig. 3).

The image intensifier "sees" the microscope image on a special fluorescent screen through a high-speed lens and a front-surface mirror. Once intensified, the image is focused onto the light-sensitive faceplate of an image-orthicon camera tube where it is converted to a television signal, the image is amplified and otherwise processed before reconverted to a visible image in the picture monitor.

As pointed out earlier, the Lenox Hill system includes a television tape recorder: an RCA Type TR-5 (Fig. 5). This unit is a self-contained, mobile system for recording and/or playing broadcast-quality video tapes.

The tape recorder is a valuable adjunct to the image intensifier because it provides means for storing dynamic, moving images for immediate or future playback without the delay of darkroom processing.

At Lenox Hill, the tape recorder serves as a teaching aid for budding pathologists in that certain images—even transient ones—can be reviewed again and again without loss in image quality. Since the images are magnetically recorded on the tape, it can be erased and recorded again and again . . . an impossibility with motion-picture or any other film process. In addition, the tapes recorded here can be played on virtually any other broadcast-quality video tape recorder. Thus, taped images might be transmitted from coast-to-coast via a closed-circuit video network should the need arise.

Through the generosity of the Kalvin Family, Lenox Hill Hospital can boast the first medical application of a microscope image-intensification system based on television principles.

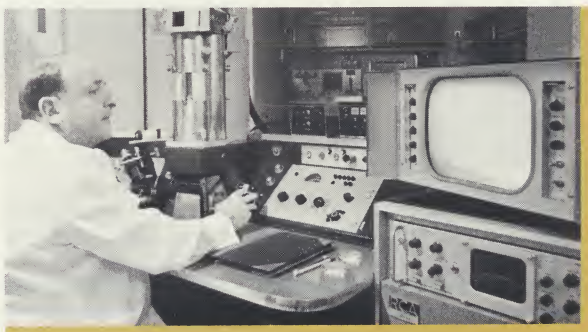


Fig. 1. Dr. Stanley R. Opler demonstrates the image intensifier system given to the Hospital by the Kalvin Family.

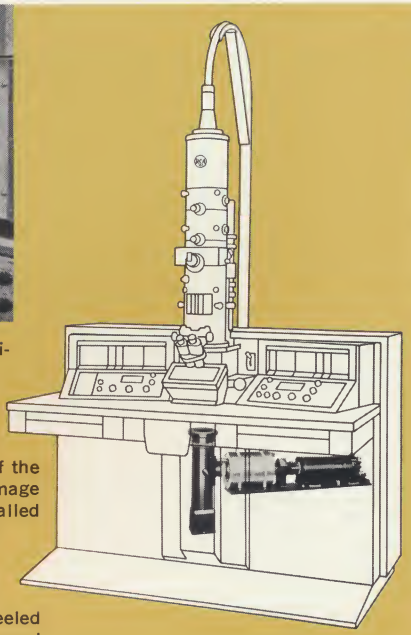


Fig. 2. Phantom view of the optical portion of the image intensifier system installed in a microscope.

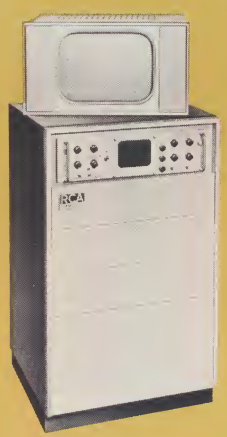


Fig. 3. Full view of the wheeled cabinet that houses the several image-intensifier electronic circuits and picture monitor.

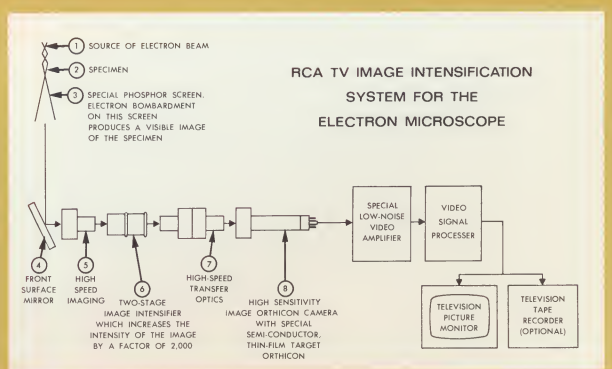
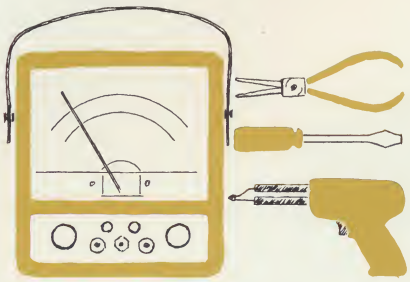


Fig. 4. Block diagram of the image intensifier system from the microscope beam to the picture monitor.

Fig. 5. The semi-portable television tape recorder used to store the converted-to-TV microscope images on magnetic tape.



MEET THE SERVICE ENGINEER

AL REVZIN

Known to virtually every electron microscopist in the Manhattan, the Bronx and Westchester sections of New York, Al Revzin—the local RCA Service Company representative — began servicing RCA instruments some six years ago following a five-year stint as maintenance engineer for RCA Theater- and Industrial-Sound Systems. In those eleven years, Al has firmly established himself as a capable, cooperative and conscientious service engineer. The move from sound systems to electron microscopes was—to use his own words —"a most happy event for me".

In the early days, Al recalls, his territory ranged from Buffalo (NY) to New Haven (Conn.) and from the Ontario lakeshore to the N. Y.-Pa. state line. Because of the great concentration of RCA instruments in the greater New York area, Al needn't range quite so far nowadays.

In those six years as an electron microscope service engineer, Al has installed EMU-2's, the eight versions of the EMU-3 (A thru H) and the first EMTV-1 Image Intensifier System (at Lenox Hill Hospital, New York City). He eagerly awaits the first EMU-4 destined for installation in his territory.

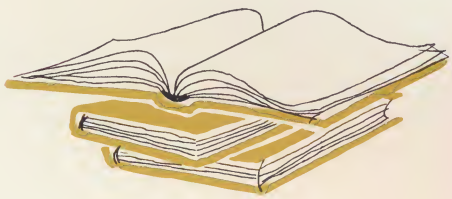
Photographer, Tinkerer, Home-Handyman

In private life, Al and Norma Revzin are the parents of two daughters: Liane and Fern. Daughter Liane is a sophomore at Stony Brook University and Fern is a Senior at Walton High School in the Bronx, where the Revzins make their home.

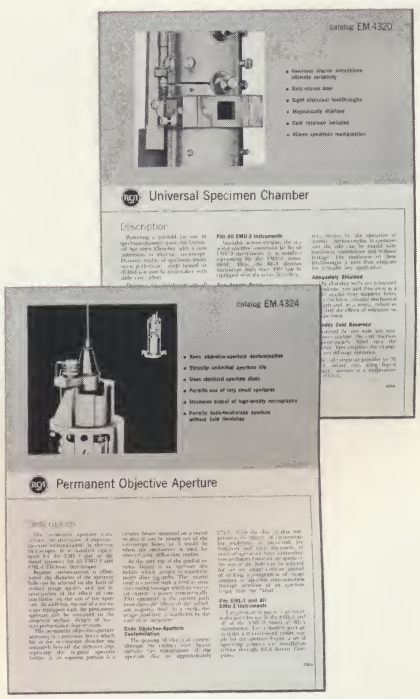
In his spare time, Al is a portraiture photographer, a "flat" and stereo color-slide fotog, an electronic-gadget tinkerer and a home "fixer-upper". These relaxers sure reflect his technical prowess.

Al is a strong believer in routine maintenance. His helpers are his "trusty" volt-ohm-milliammeter an oscilloscope (an RCA WO-33, naturally) and a heavy bag of "goodies". He prides himself on the fact that the oldest EMU-2 and the latest EMU-3H in his territory are functioning at the peak of their ability.

Any of the literature described in this column is available from RCA Scientific Instruments Advertising, Building 15-5, Camden, N.J. 08102. Please request each piece by number.



NEW LITERATURE



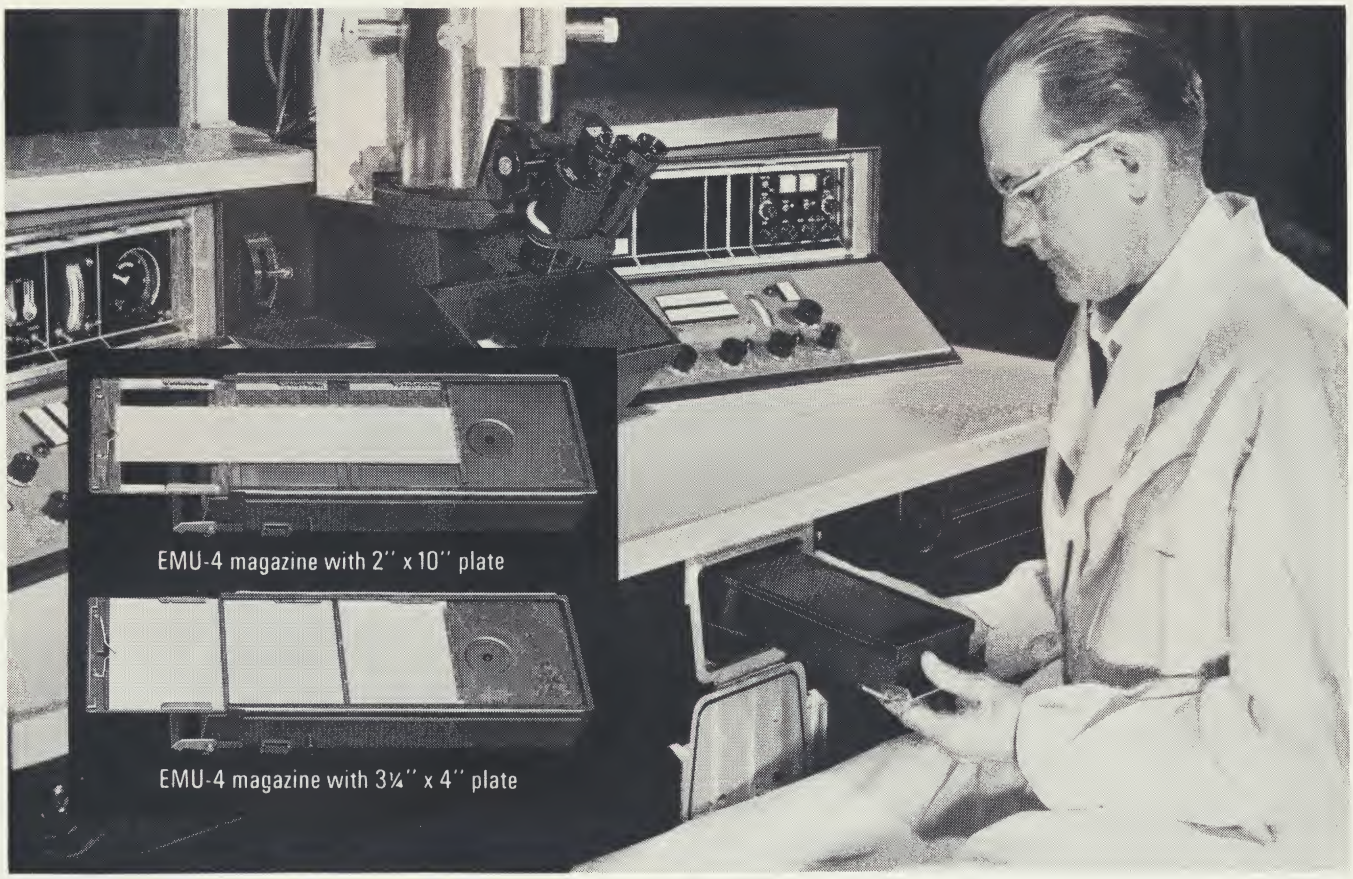
Universal Chamber–EM.4320

Providing a ten-fold increase in specimen chamber space as compared to "standard" chambers, the RCA Universal Chamber is designed for installation on all EMU-3 instruments (—3A to 3G, chamber is standard equipment on —3H). This two-sided product sheet describes various features and benefits afforded by the chamber as well as appropriate ordering information.

Permanent Aperture–EM.4324

Offered as optional equipment for all RCA EML-1 and EMU-3 electron microscopes, the permanent objective aperture accessory ends forever the annoyance of aperture contamination. With contamination eliminated, the aperture size is selected on the basis of contrast and not on the anticipated life of the aperture. This two-sided sheet discusses various aspects of the accessory.

EMU-4...The "New Look" in Electron Microscopes



Front-loaded magazine holds 6 cassettes

Which plate size is best for electron micrographs?

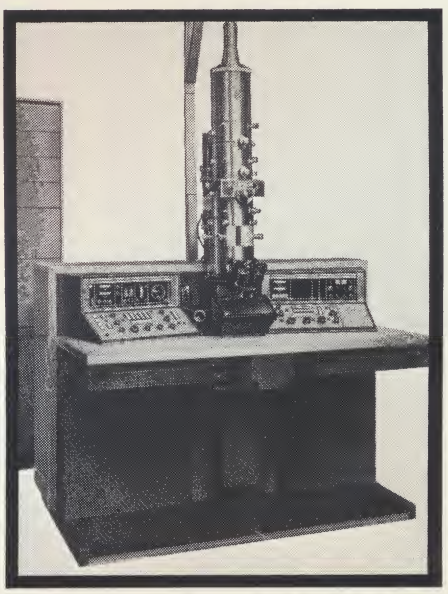
The best plate size is a *standard* size, for only a standard size gives you a selection of emulsion characteristics, is easily and quickly available in local supply and demands no premium in price.

The EMU-4 plate cassette—there are six in a magazine load—is designed with those thoughts in mind: They accommodate—interchangeably—the standard 2" x 10" spectroscopy plate or the standard 3¼" x 4" projector-slide plate or cut film in 4" x 10" pieces (which is precisely one-half of a standard 8" x 10" piece of sheet film).

Since they are universally available, these plates are competitively priced, offer wide choices of emulsion types and are usually stocked at local supply houses.

Using standard-size photo materials is but one of the many features of the new EMU-4. Among the others are: transistorized, modularized electronics; an almost-impossible-to-contaminate objective aperture; a truly universal specimen chamber; a quick-change specimen airlock and many others.

For additional information, write RCA Scientific Instruments, Bldg. 15-5, Camden, N. J. 08102. In Canada: RCA Victor Co., Ltd., Montreal. Overseas: RCA International Division, Clark, N. J. 07767.



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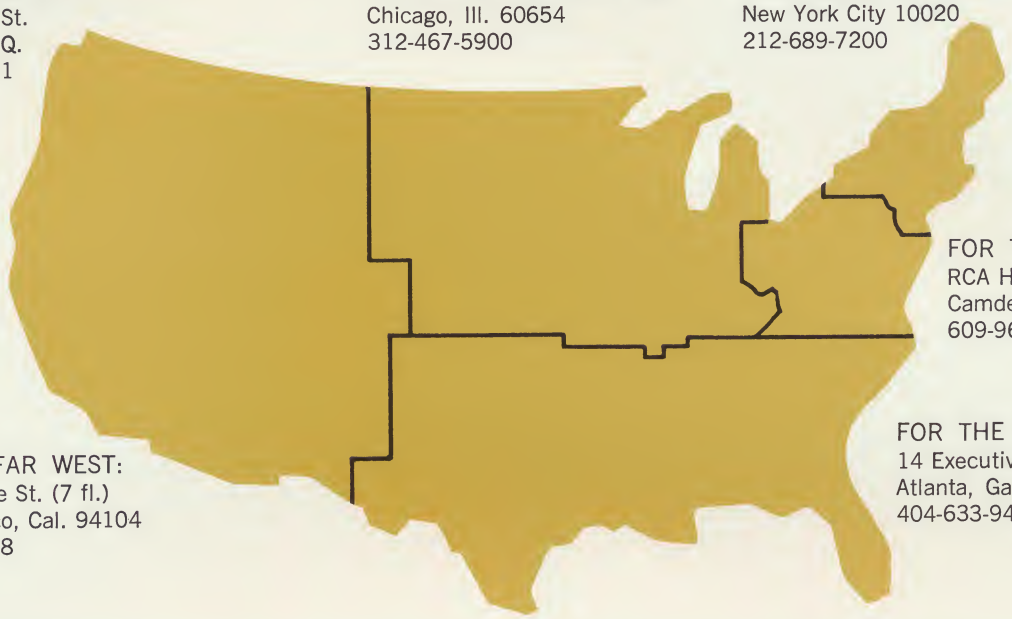

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Addenda to:

A RAPID METHOD FOR STAINING PLASTIC EMBEDDED TISSUE FOR LIGHT MICROSCOPY

DELBERT E. PHILPOTT

Scientific Instruments News

Vol. 11, No. 1

In this article, *Minit Grip* epoxy glue was used as a substitute for *Klenk's Fast Setting* because the latter was no longer available. Since that writing, *Klenk's* has again become available from Cynolite Corp. of Compton, Cal., while *Minit-Grip* has become the product of Pace Home Products, a division of Cory Corp., 3200 W. Peterson Ave., Chicago, Ill. 60645.

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